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ACTIVITIES OF THE UNITED NATIONS SYSTEM IN SCIENCE AND TECHNOLOGY FOR DEVELOPMENT INCLUDING THOSE OF THE CENTRE FOR SCIENCE AND TECHNOLOGY FOR DEVELOPMENT, THE ADVISORY COMMITTEE ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT AND THE UNITED NATIONS FUND FOR SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

Report of the Advisory Committee on Science and Technology for Development on its eleventh session

CONTENTS

		Paragraphs	Page
I.	A NEW PERSPECTIVE FOR SCIENCE AND TECHNOLOGY FOR DEVELOPMENT	1 - 9	3
II.	SUSTAINABLE DEVELOPMENT: CONCEPTUALIZATION OF THE BASIC PROBLEMS	10 - 14	4
III.	INTERNATIONAL COOPERATION FOR ENDOGENOUS CAPACITY BUILDING	15 - 19	6
IV.	TECHNOLOGY MISSIONS	20 - 24	7
V.	STAKEHOLDERS' DIALOGUES	25 - 28	7
VI.	FINANCING SCIENCE AND TECHNOLOGY FOR DEVELOPMENT	29 - 33	8

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CONTENTS (continued)

		Paragraphs	Page
VII.	SUBSTANTIVE THEMES BEING CONSIDERED FOR FUTURE WORK	34 - 38	9
VIII.	THE IMPACT OF THE ADVISORY COMMITTEE	39	11
IX.	ORGANIZATIONAL MATTERS	40 - 47	11
	A. Opening and duration of the session	40 - 44	11
	B. Attendance	45	12
	C. Election of officers	46	12
	D. Agenda	47	13

Annexes

I.	SUSTAINABLE DEVELOPMENT: THE BASIC PROBLEMS AND RECOMMENDATIONS	14
II.	ENDOGENOUS CAPACITY BUILDING IN SCIENCE AND TECHNOLOGY THROUGH INTERNATIONAL COOPERATION	22
III.	ANALYSIS OF THE TECHNOLOGY MISSION CONCEPT BY THE ADVISORY COMMITTEE .	27
IV.	FINANCING SCIENCE AND TECHNOLOGY FOR DEVELOPMENT	32

I. A NEW PERSPECTIVE FOR SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

1. International negotiations for a global environment management regime are likely to be far more difficult than the international community has experienced in the past in combating the problems of global climate. It has been said that if the Montreal/Vienna process was a 100-metre race, and the Law of the Sea talks a marathon, full negotiations regarding climate would be a decathlon. 1/ This complexity is not only because the talks would have to focus on how to allocate sacrifices rather than benefits; but also because they would potentially affect a very wide range of economic activities, including patterns of agriculture, industrial production and consumption, indeed, development in general. The advocates of a global climate control regime should be warned that the projected rate of emission of greenhouse gases by 2050 will be some 40 per cent higher without the cooperation of the developing countries than with it. A great deal of ingenuity and enthusiasm will be required to address problems at issue and manipulate the interests at stake into mutually satisfying positive outcomes.

2. The "decathlon" thus presents itself as a great opportunity for re-examining and re-travelling the approaches to a wide range of important issues of development, including trade, debt, finance, science and technology, and even disarmament. Admittedly, trade deficits, debt relief, famine, natural disasters and other variable crisis syndromes will continue to demand urgent remedial action, and the international community may be kept busy reshuffling its portfolio of priority projects for development cooperation. We are all aware, however, that the span of a quarter to a half a century will be needed for firm, steady investment in building scientific and technological capacity to generate a tradition of strength and excellence in research, competitive production and management sensitive to change.

3. A still longer time-frame will be implied when we think about resource depletion and environmental sustainability and how these aspects of Nature impede or disrupt the economic and political processes we are accustomed to. It is indeed a challenge for both national and international policy authorities to observe such a secular time-frame. Given the uncertain prospect of global warming, and the underlying complexity of scientific knowledge at stake, it is most urgently necessary to set in motion joint efforts of both the developed and the developing countries to expand the knowledge base for rebuilding Man-Nature relationships and exploring the promise of "sustainable development". This would be crucial if only for further collective legitimization of the problems at issue in the negotiations for a global environment management regime. It is in this perspective that international cooperation in science and technology is emerging at the forefront of the agenda for the forthcoming Global Conference on Environment and Development.

4. The Advisory Committee on Science and Technology for Development, at its eleventh session (January 1991), identified the most pertinent issues relevant to science and technology and sustainable development emanating from the totality of its work during the past few years. Its deliberations have pursued the following four themes:

Sustainable development,

International cooperation for endogenous capacity building,

Technology missions,

Financing science and technology for development.

5. Work has progressed across the board from one theme to another, especially in the degree of "operationalization" achieved in shaping the key concepts and possibilities for action in the respective areas. But the Advisory Committee's work on the four themes happens to share a common set of preoccupations: among others (a) a commitment to long-term investment in endogenous scientific and technological capacity building in developing countries (one of the overarching themes of the Vienna Programme of Action); and (b) a conviction that this long-term commitment is tailored to the requirements of specific priority initiatives in development cooperation. These in turn should be identified through participatory decision-making processes, addressing particular local problems, such as food security, water and soil management, reforestation, energy efficiency, export industry development, communication, subregional cooperation and trade ventures.

6. Our search for a new paradigm of sustainable development has thus concentrated on "acting locally while thinking globally". It is hoped that global thinking will thrust forward steadily and integratively, building an ever more serious search for sustainable development at national and grass-roots levels. The Advisory Committee recognizes the need for providing enhanced opportunities and improved mechanisms to facilitate meaningful interactions between such developmental efforts at the grass-roots level on the one hand, and the work in progress towards sustainable Man-Nature partnerships at regional and interregional levels on the other.

7. Sections II-VIII of this report lay down in succinct terms a set of salient propositions in relation to each of the four themes that may be of particular interest to the Intergovernmental Committee on Science and Technology for Development.

8. Some additional thoughts are presented regarding target problem areas of global significance that the Advisory Committee might wish to take up for its future programme in support of the work of the Intergovernmental Committee.

9. More detailed discussions of the four themes from which these propositions are derived are summarized in annexes I-IV.

II. SUSTAINABLE DEVELOPMENT: CONCEPTUALIZATION OF THE BASIC PROBLEMS

10. One of the major challenges to policy makers concerned with sustainable development is how to cope with surprises and develop hedging strategies. A societal ability to "manage changes" in this sense demands a techically literate population as well as a scientific and technological community well integrated into international peer networks. Perhaps the most compelling argument for endogenous capacity building in developing countries is the necessity for resilience to deal with unexpected events and recurrent turbulence.

11. Priority problem areas for international cooperation towards sustainable development include, among others:

(a) Sustainable development of cities: a new socio-technological paradigm for management of the problems of urban development;

(b) Sustainable development of agriculture and forestry: the need for an improved arsenal of public policies to deal with the problems of rural poor, and development of new socio-technical capabilities to tackle the problems of deforestation, soil degradation, desertification, unsustainable farming practices, including excessive use of fertilizers, pesticides and herbicides;

(c) Sustainable development of industry: development of capabilities to participate gainfully in international competitive markets, coupled with internationally harmonized policies to ensure that industrial products and processes are both economically competitive and environmentally acceptable;

(d) Sustainable development of energy systems: reliable and price-competitive energy supply, including systematic studies on alternative energy systems and energy conservation/efficiency technologies.

12. While environment protection is a predominantly public-sector affair, it does not follow that environmentally sound technologies should all be "public goods". The challenges of technology transfer in the area of environmentally sound technologies are threefold:

(a) To devise mechanisms which permit appropriate compensation from developed countries Governments for any extra investment costs involved in the diffusion of such technologies in developing countries;

(b) To provide incentives (e.g. carbon tax credits) for innovative private firms to invest, through partherships with developing country institutions, in the development and diffusion of technologies adapted to local ecological and economic conditions in developing countries;

(c) Great care to be exercised so that the short-term special deals along the terms of (a) above should be time-phased in order not to retard the build-up of endogenous innovation capacity in developing countries and regions, so that they will adopt appropriate environmentally "friendly" technologies as rapidly as possible.

13. Globally programmed environmental investment in developing countries and regions may often produce greater global environmental benefits than environmental investment within developed countries themselves. Because of the incremental environmental benefits per unit cost, by bringing cleaner technologies to developing countries benefits will often be much higher than further improvements on already relatively clean technologies in developed countries.

14. Development and diffusion of environmentally sound technologies involve much adaptive research and experiment tailored to local ecological and economic

conditions, as in the case of agricultural technologies. Thus, the experience gained by the research centres of the Consultative Group for International Agricultural Research (CGIAR) may offer a useful frame of reference (though not a model) for organizing a multinational approach to strategic research and extension services in environmentally sound technologies. However, development of national research laboratories and extension services may be a necessary condition for such multilateral programmes to be truly effective. Emphasis should also be put on the creation of internationalized extension services including mission-type approaches for guidance in the setting of priorities and policy actions at the local level, with a view to facilitating the process of thinking globally while acting locally for sustainable development.

III. INTERNATIONAL COOPERATION FOR ENDOGENOUS CAPACITY BUILDING

15. Every international cooperation project should be assessed in terms of its contribution to endogenous scientific and technological capacity building. This will require the development of appropriate criteria for measuring such impact.

16. International cooperation projects must be designed to fit into a coherent vision of a nation's overall development strategy. The formulation of such a national vision can be assisted by a consensus-building process among national stakeholders.

17. The so-called "Tripartite Technical Co-operation" scheme, involving partnership between a newly industrialized country, an advanced country (or international organization), and a recipient developing country, is believed to have merit in facilitating the cross-cultural process of technology transfer and long-term partnerships, especially in areas involving newly emerging technologies.

18. A menu of "creative mechanisms" for financing development and diffusing environmentally sound technologies, was proposed at the United Nations Workshop on Creative Financing for Environmentally Sound Technologies (held at Belém, Brazil, in December 1990). It merits special attention as an instrument for global thinking in the context of endogenous capacity building. The subject was also referred to in the report of the Secretary-General on ways and means of ensuring the participation of developing countries in international cooperation for research and development on environmentally sound technologies (A/CN.11/95). But due regard should be paid to the points raised in paragraph 11 (c) above.

19. Partnership between private and public institutions can enhance the likelihood of development of more competitive and enviornmentally benign industries than intergovernmental partnership projects. Such partnerships, and their contribution to the widening of R&D infrastructure in developing countries can be of decisive importance to industrial development. But appropriate policy support is essential in ensuring the development of dynamic links between such partnerships and local universities, public laboratories, training and extension service facilities.

IV. TECHNOLOGY MISSIONS

20. There has been widespread disillusion in many developing countries about the lack of continuity between "planning" and "implementation" that has resulted in underutilization of local human and infrastructural resources vis-à-vis the declared priority objectives. Technology missions represent a problem-oriented, multisectoral approach. Inspired by an experience in India, they have proved to be a valuable device for mobilizing national technological resources in order to bring solutions to high-priority problems envisaged in a country's development strategy.

21. This approach has proved instrumental in promoting organizational learning among the national authorities concerned with the application of science and technology for development, triggering improved linkages between research, training and production, and also enhancing opportunities for blending new with old technologies. It should also serve to ensure that technologies adopted should be socially, economically and politically acceptable, enviornmentally sound and predictably implementable.

22. It is desirable for the technology mission type of exercise to be carried out to include extensive dialogue for consensus-building among stakeholders in the nation-wide development process, thus compiling a portfolio of proposals for priority action, which would then become the focus of domestic and external resources.

23. The experience of countries that have applied the technology mission concept could provide a valuable source of south-south cooperation in the identification, formulation and organizational stages of such missions.

24. Stakeholders' dialogues need to be disciplined so that differences in problem perceptions, interests and values can be dealt with constructively: it is not only a matter of practical art but also an important facet of policy sicence. In the interests of environmentally sound technology assessment, stakeholders' dialogues must be informed by other relevant natural science disciplines that are crucial in injecting a due element of "global thinking" when dealing with local problems. Both the art and science of stakeholders' dialogues need continual crystallization, drawing on the experience of different developing countries with different cultural, political and economic structures.

V. STAKEHOLDERS' DIALOGUES

25. The countries interested in applying a technology mission-type of approach can benefit from the experience gained in those countries that have already done so. In the report of the Panel of Experts on Technology Mission it was proposed that case-study materials related to technology missions be given widest dissemination (A/CN.11/AC.1/XI.2).

26. The United Nations Centre for Science and Technology for Development has promoted in a number of developing countries a consensus-building participatory decision-making process to achieve a portfolio of priorities in science and

technology responding to development demands. The unique feature of this approach is its focus on endogenous capacity building.

27. The resulting outcome in the form of the prioritized portfolio ranges from policy to projects. The stakeholders engaged in dialogue will acquire a clear understanding of the underlying assumptions behind the analyses of the Advisory Committee of sustainable development, international cooperation in support of endogenous capacity building, technology missions and the financing.

28. It is recommended that the Centre for Science and Technology for Development should continue to serve as an international centre for promotion of policy dialogues for the planning and implementation of science and technology initiatives in developing countries, resulting in technology missions aimed at environmentally sound and sustainable development; and to function as a reservoir of knowledge and expertise.

VI. FINANCING SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

29. The concept "science and technology for development" encompasses a wide range of activities. Part of these activities and the knowledge they generate can be regarded, along with capital, labour and natural resources, as inputs to sectoral development objectives. Another part of the activities cuts across many sectors and provides a common base on which all development activities can be founded. Indeed, many of the industrialized countries recognize this duality and refer to the need for government policies to support the science base as well as policies to promote technological inputs to industry, agriculture, health, etc.

30. The financing of these diverse activities is itself a diverse process. The Advisory Committee recognized this diversity and further recognized the contribution of public and private funds, of national and international sources and the fact that endogenous capacity for science and technology includes many activities of which R&D is only a relatively small component (usually less than 10 per cent of qualified scientists and engineers are engaged in research).

31. The Advisory Committee took note of the fact that more than 80 per cent of the funds for scientific and technological activities in developing countries come from domestic sources and less than 20 per cent are from international sources. It therefore gave particular attention to new ways of generating domestic sources of funding for science and technology and tried to identify ways in which international sources might have greater impact on endogenous capacity building.

Domestic sources of funds

32. The Advisory Committee considered a wide range of mechanisms and policy instruments which could generate resources for local scientific and technological activities. Most of these have local rather than general applicability and its advice on this issue is for Governments to explore a wide range of possible instruments and to choose those which are most relevant to their domestic situation. The Belém Workshop referred to in paragraph 17 provided examples of the sort of approaches which might be followed.

International sources of funding

33. International sources of funding are both public and private. Foreign private sources of funding for science and technology are an extremely important component of international transfers. The Advisory Committee, however, did not have the relevant information available on which it could pass informed judgement and develop advice on this aspect of international funding. It concentrated instead on the flows of government aid funds through both bilateral and international agencies. It recognized the difficulties of generating a single major fund to finance science and technology activities in developing countries, and further recognized that different donors, both bilateral and multilateral, have different objectives and guidelines which determine the type of projects they are prepared to support. In the light of the above the Advisory Committee recommends that:

(a) Developing countries should formulate a development strategy explicitly recognizing the contributions to be made by an endogenous science and technology capability. Priorities should take note of the views of different stakeholders in the development process;

(b) The contributions of both domestic and international sources of funds to this strategy can then be matched provided national priorities and donor interests are defined;

(c) The successful implementation of this advice will require a greater coordination of donor agencies than has hitherto been achieved. This coordination may eventually lead to a loose coalition in which a small international agency acts as a matchmaker between donor and recipients;

(d) Most projects supported by donors do not appear to leave behind an enhanced local science and technology capability. Given the importance which the Advisory Committee puts on this objective, it also recommends that before funding, each project be assessed for its likely contribution to endogenous capacity building. Such an impact statement would help to focus the attention of both donor and recipient on this issue and help in the final choice of aid projects.

VII. SUBSTANTIVE THEMES BEING CONSIDERED FOR FUTURE WORK

34. The Advisory Committee identified three possible themes for its future work programme. In arriving at these themes note was taken of the decision of the Intergovernmental Committee at its eleventh session to choose its substantive themes on the basis of the General Assembly agenda, and by the suggestions of possible themes made by the Bureau members of the Intergovernmental Committee at their informal meeting on 15 November 1990.

35. The themes selected by the Advisory Committee for more detailed consideration by the Intergovernmental Committee and the Bureau of the Advisory Committee are described below.

(1) The contribution of science and technology to the development of small developing countries

36. The main focus of the theme would be the least developed small countries, but other more dynamic small countries would be included for reference purposes. Attention would in particular be paid to:

(a) The critical mass of scientific and technological resources needed to build the early phases of an endogenous science and technology capability;

(b) Ways for stimulating greater interaction between public and private sectors in order to promote innovation in small and medium-sized enterprises;

(c) Scope, mechanisms and methods of cooperation among these countries and between them and other technologically more advanced developing countries in scientific and technological education, research, promotion and extension;

(d) Specific categories of technology with possibilities for blending new with old technology systems and elements, that are of particular relevance to small, land-locked and island countries in enhancing their strategic options towards sustainable development;

(e) Alternative "social" technologies for generating and diffusing innovations at the grass-roots level that would be of particular relevance for poverty alleviation, forestry and other land resources management.

(2) The management of technical change: new approaches to industrialization in the context of economic restructuring of developing countries

37. Under this heading a large number of specific issues have been raised, some being interrelated while others were deemed to merit a good degree of independent treatment. In summary the following three would deserve particular attention:

(a) Evolving markets of environmentally sound proprietary technologies and desirable instruments for public policy intervention, at national and international levels, to promote the transfer to and adaptive development for developing countries of such technologies, with due regard to private initiatives;

(b) Precompetitive collaborative R&D among developing country industrial enterprises and research institutions on environmentally sound technological alternatives, including adaptive engineering and extension services, and with due attention to the participation of small and medium-sized enterprises;

(c) International networking of enterprises in developing countries, including international subcontracting arrangements with attention to the critical mass of downstream markets at subregional or regional or even interregional levels.

(3) Global technology missions

38. The analysis of national technology missions carried out by the Advisory Committee led to the conclusion that such missions were frequently effective

mechanisms for mobilizing enthusiasm and resources to tackle major social and economic problems at a national level. It would be worth extending this concept to identify a number of regional and global issues that might be amenable to a similar approach. The successful application of such a similar approach to the eradication of smallpox suggests that diseases (for example) might be appropriate problems warranting global technology missions. The particular role of non-governmental organizations in the implementation of technology missions would also be worthy of further analysis.

VIII. THE IMPACT OF THE ADVISORY COMMITTEE

39. The Advisory Committee finds that the present approach, whereby its views are submitted to the Intergovernmental Committee once every two years, to be unsatisfactory. The issue of how to mobilize science and technology in order to contribute to the solution of development problems is too urgent to warrant such a long delay. Furthermore, it is far from clear to the Advisory Committee what note is taken of the advice it gives. It would like to be of greater use to the United Nations system and to be in a firmer and more direct contact with those who could benefit from this advice. It would welcome the views of the Intergovernmental Committee on this matter.

IX. ORGANIZATIONAL MATTERS

A. Opening and duration of the session

40. The Advisory Committee on Science and Technology for Development held its eleventh session in New York, from 14 to 18 January 1991. The ninth and tenth sessions were held at Vienna, Austria, and Zhuhai, China, respectively.

41. The Director-General for Development and International Economic Cooperation, in opening the session, pointed out that the role of the Advisory Committee had increased in importance, given the new mission of the Intergovernmental Committee on Science and Technology for Development to provide technology assessment services to the United Nations General Assembly on selected topics on its agenda. He was pleased to note that the present session was giving priority to the substantive theme of the next session of the Intergovernmental Committee, namely: environmentally sound technology assessment, in association with the topic of sustainable development. This was especially relevant in view of the global attention being paid to the issue of environment and development and the planned United Nations Conference on Environment and Development in 1992.

42. In the view of the Director-General, the endogenous capacity building in science and technology through international cooperation was equally important and was also linked to the question of promoting the participation of developing countries in R&D of environmentally sound technologies. The Intergovernmental Committee, the General Assembly, as well as the donor community represented in the Organisation for Economic Co-operation and Development (OECD), now supported the approach of national dialogue, involving all the stakeholders of the development

process, for the defining of priorities. They also endorsed the idea that the key to sustainable development lay in endogenous capacity building. It was also recognized that coordination and harmonization of the United Nations system would benefit from the country-level approach.

43. Despite current difficulties facing the world today, he believed that the time was ripe for new and constructive initiatives to promote international cooperation. The restructuring of the world economy in the coming decade requires substantive analysis of the potential role science and technology could play. He was of the opinion that the 1980s was a lost decade for developing countries and that their situation would not improve in the 1990s unless the critical problems facing the developing countries were not properly addressed.

44. The newly elected Chairman, in addressing the Committee at the opening, reminded the members that the session would prepare a report to the Intergovernmental Committee on Science and Technology for Development on the basis of the three years of accumulated work of the Advisory Committee. He outlined the topics to be covered, with main emphasis on the substantive theme of the Intergovernmental Committee and the topic of endogenous capacity building through cooperation.

B. Attendance

45. The full membership of the Committee is 28. The following 20 members attended the session: Carlos Abeledo, Elisabeth Birman, Donatien Bihute, Harvey Brooks, Robert Gyabaa Jones Butler, Niels E. Busch, Meneleo J. Carlos, Jr., Pierre F. Castillon, Hyung Sup Choi, Karl Ganzhorn, Ladislav Kovac, Joanna Olutunbi Maduka, Marcos Mares Guia, Geoffrey Oldham, Maria de Lourdes Pintasilgo, Yangzi Sherpa, Rosa Elena Simeon, Mikoto Usui, Josephine Guidy-Wandja and Wu Yi Kang. The representatives of the United Nations Conference on Trade and Development (UNCTAD), the United Nations High Commissioner for Refugees (UNHCR), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), the World Bank and the United Nations Industrial Development Organization (UNIDO) attended as observers.

C. Election of officers

46. The following officers were elected at the eleventh session for the year 1991-1992:

Chairman: Geoffrey Oldham

Vice-Chairmen: Niels E. Busch
Ladislav Kovac
Joanna Olutunbi Maduka
Marcos Mares Guia
Yangzi Sherpa

Rapporteur: Mikoto Usui

D. Agenda

47. The Advisory Committee adopted the following agenda:

1. Election of officers.

2. Adoption of the agenda and other organizational matters.

3. Core programme:

   (a) Sustainable development/Environmentally sound technology assessment: input for the substantive theme of the Intergovernmental Committee on Science and Technology for Development;

   (b) Endogenous capacity building through international cooperation;

   (c) Report of the Panel of Experts on Technology Missions;

   (d) Financing science and technology for development.

4. Additional inputs for the Intergovernmental Committee on Science and Technology for Development:

   (a) Selection of substantive themes for the Intergovernmental Committee;

   (b) Planning and management of science and technology policy.

5. Other matters:

   (a) Activities of the Centre for Science and Technology for Development and other organizations and bodies of the United Nations system;

   (b) Future programme of work.

6. Adoption of the report of the Advisory Committee on its eleventh session.

Notes

1/ James K. Sebenius, "Negotiating a regime to control global warming" (unpublished manuscript), Kennedy School of Government, Harvard University, October 1990.

Annex I

SUSTAINABLE DEVELOPMENT: THE BASIC PROBLEMS AND RECOMMENDATIONS

A. Different meanings of "sustainable development" and "environmentally sound technology"

1. General definitions of sustainability, or environmental soundness, are difficult to translate into operational criteria that can be applied to choices among available technologies so as to be appropriate in the local social, economic, political and cultural context.

2. Furthermore, the terms "sustainable development" and "environmentally sound technology" are not interchangeable. Environmental soundness is relative, and is not an attribute only of technology, but of technology embedded in a host of policies and strategies with respect to deployment, diffusion and social utilization of a technology within a larger socio-technical system.

3. Sustainability should be a minimum criterion for environmental soundness, but not every environmental improvement or active policy for the conservation of natural resources can be considered as sustainable in an overall socio-technical sense. For example, an environmentally sound technology that was not affordable, or which excluded many segments of society from economic advancement in a given stage of economic development, could not be regarded as socially sustainable.

4. A sustainable policy for the selection and deployment of technology is one that forecloses as few future options as possible, compatible with any given level of present benefit. A technology providing short-term benefit today at low cost may prove more costly in the long run if at some future time the environmental or social dislocations it causes exceeds the economic surplus it generates. A satisfactory assessment of currently available choices requires projection of the consequences of current trends if their use continues to be expanded. It also requires projection of alternative end-points resulting from the adoption and exploitation of new and emerging technologies, taking into account costs, endogenous capacity for managing the technologies, and realistic time scales for investment.

B. Importance of locally oriented technology assessment in the context of global problems

5. Problems such as greenhouse warming or stratospheric ozone depletion require global solutions that have to be negotiated collectively, but local technological responses may be different, depending on locally-oriented technology and economic assessments.

6. The final objective must be to achieve a given increment of development with minimum adverse environmental impact on a global basis. In the CFC (chlorofluoro-carbons) case, the chemistry of replacement products will doubtless

be developed in the major research facilities of companies in developed countries, but the application of such products (e.g. in refrigerators, air conditioners, foam expansion) could be locally developed and promoted. In the case of carbon dioxide emissions, one should aim at the largest possible emission reduction for a given investment, regardless of location. This may often be in developing countries where energy production and consumption are less efficient and the demand for energy is growing faster. Thus, improvement of local technologies, such as in combustion efficiency, might have higher priority than further improvements in energy efficiency in developed countries, other things being equal. Attention could also be given to local possibilities such as hydropower or solar energy (but only in applications that promise to be economically viable in the relatively near term).

C. Importance of surprise, and means for achieving resilience in the field of surprise and scientific uncertainty

7. One of the major threats to sustainability in development may be the appearance of surprises and discontinuities. Recent examples are the discovery of the Antarctic "ozone hole", the catastrophic accidents at Chernobyl and Bhopal, the dramatic spread of the AIDS epidemic world-wide, or the scientific discoveries leading to rapid development of biotechnology. Such surprises often produce a huge societal response and rapid shifts in science and technology priorities. None of these events was foreseeable, especially as to their timing relative to many other political or technological developments. One of the major challenges to policy analysis for sustainable development is how to cope with the possibility of surprise, both favourable and adverse, and to develop contingency plans or "hedging" strategies that take into account not just the most probable trends, but also the unexpected. Proposed development strategies or technology adoptions must be assessed not only with respect to their expected benefits, costs and risks under existing trends but also with respect to their sensitivity to unanticipated events, both favourable and unfavourable.

8. Perhaps the most compelling argument for the build-up of endogenous capacity in developing countries is the necessity for resilience in the face of such unexpected trends and events. The kind of capacity needed is more generalized and less sector-specific than that needed for ordinary technico-economic development, and is thus harder to plan for. It includes a technically literate population as well as a scientific/technological community well-integrated into international networks. It also suggests some attention to research without direct and immediate application to development goals.

D. Recommendations

1. Priority fields for international cooperation in environmental and sustainable development issues

9. The Committee has identified four priority problem areas in developing countries of a magnitude and character that make international cooperation imperative if solutions are to be found in time.

10. Sustainable development of cities: especially major ones. Such development requires improved understanding of the functioning and subsequent locally appropriate development of urban infrastructure. This infrastructure consists of two parts. One is the infrastructure supporting urban "metabolism" (energy, water, sanitation, solid waste). The other is the infrastructure supporting the mobility of people, goods and information, that is, public transporation systems, roads and communications.

11. In developing countries, many cities, in particular major cities, are on the verge of collapse. Such cities are believed to be above critical size for their current infrastructures. It is important that new socio-technological development strategies be brought to bear on their problems.

12. Sustainable development of agriculture and forestry: the problems are considerable, ranging from deforestation - in particular destruction of tropical forest - soil degradation and desertification, farming methods which are inappropriate to the local environment, including excessive or uninformed use of fertilizers, pesticides and herbicides, as well as inappropriate choices of crops.

13. Sustainable development of industry: industrialization is at the root of the process which will ultimately be needed to bring about a more equal distribution of wealth in the world and improved living standards in the developing countries. At the same time, industrialization along the path followed historically in the developed world would entail a threat to the environment which would be unsustainable under today's conditions.

14. Means and ways must be found to develop industrial processes and products that are both economically competitive and environmentally sustainable. Problems can be avoided and competitive, environmentally acceptable industrial complexes may be established by employing new technologies that are of more recent vintage but adapted to local resources, human capacities, and infrastructure. This will require new thinking that is best developed collaboratively between developed and developing countries. Simple international mechanisms to monitor the transfer of technologies and their effect on the environment are needed. There is a particular danger that technologies and equipment which have been phased out by industrialized countries will be transferred or sold to other countries with more lax regulations. Surveillance and action are needed to forestall this.

15. Sustainable development of energy systems: reliable and price-competitive energy supply is inseparable from industrial and societal progress. Proper energy systems analysis should be applied in order to systematically study and characterize alternative systems before they are implemented. Especially, the development of electrical power supply systems is of great importance to the developing countries. Since such systems are especially capital intensive, the cost-effectiveness of this investment is of critical concern. It represents a high proportion of all the investment requirements of developing countries.

16. The Advisory Committee finds that solar power (including wind power and other renewables) has an important and growing niche and that momentum should be maintained in research concerned with solar power. Nevertheless, the Advisory

Commitee finds it necessary to inject a note of caution. The development and market penetration process for renewables will in all likelihood be so long that it would be questionable for a country to plan for renewables as its principal source of energy for any time in the near future.

17. The Advisory Committee encourages study of opportunities for the use of natural gas which has considerable environmental advantages over oil and coal. Nuclear power is the fastest growing energy source world-wide despite the fact that it is seldom mentioned as a promising alternative. The vulnerability of the world-wide system to potential public reaction to another catastrophic accident anywhere in the world makes nuclear power a global issue. Nevertheless, continuing assessment of the nuclear alternative should be maintained. Nuclear power cannot be written off as an option at the present stage of world development.

18. Finally it should be emphasized that in the long run, sustainable development is impossible without control of population growth. This implies continued emphasis on the development of cheaper and easier to use contraceptives as well as more efficient methods of motivating their widespread use.

2. Suggestions regarding mechanisms for technology transfer for environmentally sound technologies

19. Much environmentally sound technology, particularly in agriculture, lies in the public domain, so that the problem of technology transfer is more one of assimilation than of access.

20. However, there is also a need for an information network that provides an efficient mechanism for exchange of information about environmentally sound technologies, assessments of them, and of practical experience with their use.

21. Even in agriculture, however, there is an increasing trend towards privatization of agricultural technology, which in a few cases has had a significant inhibitory impact on the availability of technology in developing countries. This is an area that requires monitoring and possible future action.

22. Proprietary technology is here to stay and is mostly in the hands of the private entities that have created the technology. Therefore, the challenge of technology transfer in the area of environmentally sound technology is to devise mechanisms that permit publicly funded intermediary institutions to purchase licences from private owners on a selective basis and make them available (with relevant support services) to institutions, private and public, in the developing countries. The criterion for free licensing should be the level of environmental benefit provided compared with alternatives. Funding for such intermediary institutions should come from Governments of the developed countries.

23. There exists much proprietary technology which is no longer of value in the developed world but could provide substantial environmental benefits in developing countries. An example is residential coal heating, which has been banned in most developed countries, but which will inevitably be used for a certain period of time

in countries with abundant coal supplies like China. There is a need to identify such technologies and to provide incentives for their further development and marketing through partnerships between the owner of the technology in developed countries and an entity, public or private, in the developing countries. The intermediary institution proposed above could serve as broker for this purpose.

24. In some cases, developing countries have demanded compensation from developed countries' Governments for the difference in investment costs between environmentally sounder technology and the existing alternative in use. In the long run, this is not a desirable procedure, since it exacts an opportunity cost in terms of resources available in the developed countries for development aid. The long-run objective should be to phase out such special deals because, although they may be represented as add-ons in the short term, they will inevitably eat into development aid in the long term, and they may retard the build-up of endogenous innovation capacity in respect of the technologies involved.

3. Global environmental investment in LDCs may produce greater world benefits than investments within LDCs themselves

25. Global environmental investment in developing countries may often produce greater world benefits for the environment than investment within developed countries themselves. For example, thinking globally should encourage a focus on energy savings where the growth of consumption is highest and where the efficiency of energy production and use is lowest. This consideration suggests a special effort to bring clean technologies to developing countries in preference to often more expensive further marginal improvements in developed countries. Methods should be sought to stimulate investment by LDCs in both cleaner technologies and more efficient energy generation and use in developing countries. This would have an additional dividend in building endogenous capacity to manage energy in developing countries. For example, in areas of the world where carbon taxes have been established, the proceeds of such taxes should be used primarily to invest in the best carbon dioxide (CO_2) reduction projects on a world scale. A real incentive for private industry of the developed world would be a system of "CO_2 reduction credit" that would encourage private investments in locations where a given amount of CO_2 reduction can be achieved at the lowest cost.

26. Considering, for instance the huge coal consumption by households in China, simple technology transfers in clean and efficient residential coal heating could become profitable for all partners. An environmentally friendly energy policy also suggests the encouragement of the use of natural gas instead of coal and oil, which may give new prospects to developing countries where there are still large actual or potential reserves of natural gas. Research projects to improve the local use of gas, including conversion projects, should be encouraged.

27. Finally a global view should call for avoiding negative developments such as transfer of CFC (chlorofluoro-carbons) production out of developed countries, following the Montreal agreement, to developing countries which are not part of this agreement. This also applies to other obsolete technologies that are pollution sources of global importance.

4. Regional institutions on the CGIAR model for environmentally sound development

28. The Advisory Committee had an extensive discussion of the proposal for the creation of regional institutions on the model of the Consultative Group on International Agricultural Research (CGIAR) for purposes of research and/or information dissemination on sustainable development.

29. While the Advisory Committee was on the whole supportive of this idea, several cautions need to be borne in mind, since the parallel between agricultural research and research on environmentally sound development is not perfect.

30. First, "environmentally sound development" is a less well-defined field, and there is no single coherent international community of scholars who could serve as a source of quality control such as is served by the Technical Advisory Committee of CGIAR.

31. Second, it is important that there be some rationale for a division of labour between different institutes in different regions and a coherent programme-derived plan for the allocation of resources among them, as well as some sort of centralized decision-making forum such as the annual pledging meetings of the CGIAR at which the institutes present their accomplishments and plans and the donors pledge their support to the institutes according to their interests and the evaluations and recommendations of the Technical Advisory Committee.

32. Third, as in the centres of the CGIAR, the function should include both research and extension. The extension function may be partly carried out through local organizations and partnerships of various kinds, paralleling the important function of national agricultural laboratories in interfacing with the CGIAR system.

33. The Advisory Committee believes that the regional institutes should be working laboratories and/or field stations, not just information centres or "think tanks". In the present state of communication information on available technologies and environmental and health data is better circulated through networks, although the institutes might serve as nodes in this network as a secondary function.

34. Ultimately, the regional institutes should aim to be staffed about 70-80 per cent by local personnel and 20-30 per cent by expatriates in order to bring a global perspective and to help build endogenous capacity through close collaboration between locals and expatriates in all aspects of the operation.

35. The research agenda of the institutes should include both regionally specific problems and universal or global problems with emphasis on technical support for regional initiatives. However, the weight of the institutes should have a regional orientation.

5. Mechanisms for consensus building: stakeholders' dialogues

36. Dialogues, as a way for people to deal amicably and constructively with differences in problem perceptions, interests, values and norms are an everyday affair.

37. In that context it is recommended that stakeholders' dialogues should be oriented to the goal of acting locally while thinking globally. "Facilitators", both local and international, and both natural and socio-scientific, can play a crucial role by informing dialogue between conflicting positions and interests, protecting it from wasteful confrontations and helping to create meaningful and attractive options for resolution of deadlocks. The participation of international experts would be useful for injecting an important element of global thinking.

38. But dialogues are not without problems. Research management involves the synthesis of two modes of research: "creation" and "evaluation". The first is used by researchers engaged in exploratory and creative work preoccupied with pushing ahead towards unpredictable and uncertain frontiers. The second is used by engineers and policy analysts engaged in the development of practicable principles and systems, looking for new and better ways of accomplishing a given societal goal by exploiting or extending existing knowledge.

39. Environmental assessment involves both of these styles. In the matter of environment, a basis of global thinking, while focusing on specific local problems, is readily available from multinational information systems.

40. There is extensive experience with stakeholders' dialogues in the developed countries in the management of environmental disputes and in the siting of hazardous or unwanted, but socially necessary, facilities such as hazardous waste sites. It would be desirable to crystallize some of the lessons learned from this experience for the benefit of developing countries.

41. Dialogues among potentially affected stakeholders are important to the social sustainability of socio-ecological systems, but these dialogues may be insufficient without surrogate representation of interests and perspectives of those who otherwise cannot directly participate (e.g. children and future generations). Otherwise, there is a danger that the consensus developed in such dialogues will neglect the interests of future generations for the sake of short-term benefits in the present.

6. Public/private research partnerships in environmentally sound development

42. The basic reason for pursuing partnerships between private and public organizations is the firm belief that such partnership - if more widely established - will enhance the likelihood of the successful development of more competitive and environmentally benign industries.

43. Such partnerships allow for better utilization of know-how and resources available in universities, government laboratories and public service institutions. Furthermore, such partnerships may be a way to catalyse the formation of networks among private industries.

44. Partnerships, i.e. private/public and private/private, and their contribution to the establishment of an R&D infrastructure can be of decisive importance to industrial development.

45. It is, however, important that the rules set up for the interaction on the one hand recognize Government's obligation to follow and audit the use of public money and on the other hand respect the nature of private business, which makes an R&D project of little interest unless proprietary rights to the commercial application of its results can be guaranteed for a certain period.

46. Another vital element in such partnerships is co-financing. Private companies should be required to demonstrate their interest and commitment by their willingness to put up risk capital, in return for influence on the critical technical decisions and the retention of some proprietary rights to the technology developed.

47. Partnership should by no means be limited to partners of the same nationality. It is considered important that partnerships be formed between partners - public or private - in the developing countries and their counterparts in the developed nations. The literature abounds with examples of how programmes for the encouragement of such partnership may be set up and of the many different forms they may take. The Advisory Committee recommended that a study be made of past experience with such relationships, organized for potential applicability to environmentally sound development.

Annex II

ENDOGENOUS CAPACITY BUILDING IN SCIENCE AND TECHNOLOGY THROUGH INTERNATIONAL COOPERATION

A. Concept of endogenous capacity building

1. "Endogenous capacity" is defined as the degree of domestic capability to exercise independent, informed judgement and initiate actions regarding acquisition, deployment and generation of science and technology for economic and social development. This capacity is to be seen in the context of increasing complexity in the ability to manage technological change.

2. There are four orders of endogenous capacity; the ability to:

(a) Make informed judgement on matters related to science and technology;

(b) Select and utilize technologies;

(c) Adapt and accrete technologies;

(d) Create new technologies.

3. The concept of endogenous capacity is evolutionary and multidimensional. The capacity in each country may vary according to the stage of its development. It may even differ in different sectors at a given time.

4. The process of endogenous capacity building in science and technology can be facilitated through international cooperation. At present many sources and modes of international cooperation are available. Full benefits, however, can only be derived if national needs and absorption capacity are realistically assessed by the relevant stakeholders in the country concerned. Recognition of the different types (technical assistance, collaborative R&D efforts and business relationships), levels and modes of international cooperation, is necessary in order to formulate a national strategy for linking international cooperation in science and technology to national needs.

B. National strategies for international cooperation

5. The existence of a definitive policy for establishing international cooperation as a means of endogenous capacity building is essential. This, in turn, must be a function of a national policy on science and technology which is integrated in the overall development plan and, as such, included in the national budget.

6. There are three policy considerations that are crucial in the development of a national strategy for science and technology:

(a) A clear-cut development policy and strategies which identify the role of science and technology in achieving these development objectives;

(b) A definitive policy on utilizing international cooperation for development of science and technology and the use of cooperation as an instrument for endogenous capacity building;

(c) Relevance to sustainable development and, in particular, the impact on the environment.

7. In addition, the following concerns should be taken into consideration in promoting cooperation:

(a) Mechanisms to link needs, objectives, means, institutional participants, specific actions etc.;

(b) Description of the process defining the strategy: Which stakeholders should participate? Who defines what? How to go from general needs or objectives to specific actions? Roles of Government, industry, universities etc.;

(c) Necessary differences in the design of strategy for a developed country as compared to a developing country;

(d) Means of stimulating participation of the different stakeholders, particularly non-governmental organizations, as proxies for the stakeless;

(e) Procedure for following up and evaluating the specific actions and the total strategy;

(f) Dialogues among the stakeholders which should result in the strategy advocated in this report.

C. Criteria for endogenous capacity building

8. It would be desirable for donor institutions to apply a set of criteria during the appraisal of proposed cooperation projects to determine whether they will contribute to increasing the endogenous capacity of recipient countries. These criteria could play a role similar to the environmental impact assessment currently applied to major financing institutions and cooperation agencies.

9. A distinction should be made between sectoral activities with technological impact and specific science and technology projects. In particular, endogenous capacity-building criteria should be applied to the sectoral projects. The criteria should aim at determining whether endogenous capacity building will be improved or not after completion of the project or activity under consideration.

10. For example, an appraisal could be made on the potential effect of the project on the country's pool of qualified human resources, its capacity to make autonomous

decisions on future technology choices and its engineering or technology development capability, as well as on the several other factors contributing to a national endogenous capacity in science and technology.

D. Guidelines for promoting endogenous capacity building through international cooperation

11. In order that recipient countries may derive full benefits from international cooperation, a number of guidelines were formulated, as follows:

Guidelines for recipients

(a) Development policies and strategies should be formulated and the role of science and technology in achieving these development objectives identified. In formulating economic policies, careful note should be taken of their technological implications;

(b) A policy and plan should be formulated regarding international cooperation for development of science and technology, and on the use of cooperation as an instrument for endogenous capacity building;

(c) Participatory mechanisms should be established for policy making, planning, coordination and promotion of science and technology;

(d) It should be recognized that donors have many different objectives for their development assistance and impose different conditions. These limitations can, to some extent, be overcome by a skilful handling of these differences in the context of a truly national development strategy;

(e) Education and training, both formal and informal, at all levels, should be a priority recognized by the consensus of the stakeholders.

Guidelines for donors

(a) Give priority to supporting projects consistent with a national development strategy: this is the equivalent of supporting a country programme strategy that takes into account a knowledge of a country or resources as well as determining national priorities;

(b) Techno-economic project feasibility studies should be carried out by in-country professionals assisted where necessary by foreign experts;

(c) Pre-project appraisals should be carried out by independent agencies, that is, by those without vested interests in the matter;

(d) Project implementation should be carried out by local skills with foreign help, if necessary;

(e) Training should be provided either in the host or donor countries for all levels of scientific and technical personnel. Training should also be given in accordance with the priorities of the host country;

(f) In order to ensure that projects do not lead to an increase in poverty, regional disparities or environmental degradation, a wide range of stakeholders in the development process should be involved;

(g) Local regulations should be respected when bringing in outside expertise, goods and services;

(h) A clear distinction should be made between aid projects and trade activities. For the former, the interests of recipients should be taken into account in identifying donors' interests; for the latter, the aim should be to achieve mutual benefits. Both categories of cooperation should contribute to endogenous capacity building;

(i) Resources should be allocated only for well-defined projects and, if necessary, monitoring and assistance in the implementation should be provided;

(j) All projects should be assessed in order to identify their potential contribution to the elements of endogenous capacity. This might provide the basis of an endogenous capacity impact statement which would be an input into assessing the priority of all aid projects;

(k) South-south cooperation should be encouraged.

E. Proposed mechanisms of cooperation

12. Current international cooperation in technology has been more formal than substantive. The technological gap between advanced and less developed countries is too great and is increasing. Understanding of each other's conditions, interests and constraints is too meagre; as a result technologies offered by donor countries prove to be inadequate or difficult to adapt to the capacities of recipient countries. There is need to design new mechanisms to render international technical cooperation more flexible and more effective in the local context.

13. In these circumstances, a tripartite cooperation system may be useful to assist the less developed countries to develop and adapt more effectively the technology needed for their economic development: what has been called a tripartite technical cooperation scheme involving the newly industrialized countries acting jointly with the advanced countries (or relevant international organizations). Such a conjunction is believed to have special merit for the technological development of the less developed countries. It could fill the gap between the recipient countries' capability to implement the recommended development strategy and the donor countries' understanding of complex situations particular to the less developed.

14. Secondly, regional cooperation in technology for development should be emphasized, in view of the advantages and benefits that may be gained by cooperation among developing countries in strengthening their ability to integrate technological considerations into development planning, by the following means:

(a) Efforts should be made to develop at the national level human resources for utilization of the methodologies developed by various ministries and agencies in the participating countries;

(b) The regional database on science and technology should be strengthened to enable utilization of the methodologies for integration of technological considerations into development planning;

(c) A regional initiative should be taken for monitoring and interpreting international technological trends with regard to both existing and emerging technologies, so that participating countries may be helped to anticipate, prepare and react to them in a manner most useful for applying the "make-some-and-buy-some technology" strategy.

15. Thirdly, in order to implement the above efforts effectively through international cooperation, it may be desirable to initiate new mechanisms for assisting developing countries. One such mechanism would be the establishment of a science and technology cooperation foundation such as that proposed by Japan and the Republic of Korea. Direct government intervention is thus minimized, especially if the foundation is managed by an international board.

16. Technology-based development planning can be achieved by determination, dedication and a strong political will - a will to chart the future of one's own country using technology as a means for development. International cooperation could enhance national initiatives by providing the added dimension of using resource optimization.

Annex III

ANALYSIS OF THE TECHNOLOGY MISSION CONCEPT BY THE ADVISORY COMMITTEE

1. The choice of technology missions as the topic for analysis by the Advisory Committee on Science and Technology for Development was inspired by experiences in India which were brought to the attention of the Committee when it met there in 1988. A technology mission is a task-oriented approach to development, a methodology and activity intended to solve a pressing local, national or international problem or to exploit a socio-economic opportunity. It is a concentrated and time-limited endeavour which efficiently utilizes or develops suitable technologies as essential tools to attain specified targets, while covering associated social, economic and ecological aspects. It carries with it a sense of urgency requiring missionary zeal and the expeditious mobilization and optimization of resources. These can be facilitated through an interactive participatory management approach.

2. A technology mission can also be considered as a means of endogenous capacity building responding to the driving forces of demand or opportunity.

3. For in-depth analysis of experiences of countries that have conducted the equivalent of technology missions, a Panel of Experts was convened in Serock, Poland (11-14 September 1990).

4. All parties concerned with the technology mission approach should be made fully aware of the manner in which available science and technology capacity may be mobilized to solve pressing socio-economic problems involving full participation of all the stakeholders. Such participation would also avoid undesirable environmental, social and other consequences. In addition, beneficiaries should be made aware of the potential benefits of science and technology, which are not limited to the small segments of society.

5. The formulation phase of a technology mission can begin only when a key societal problem has been precisely identified and when the basic concepts of how to overcome it have been addressed. It is equally important, during this "creation" phase of a technology mission, to obtain a solid expression of a strong political commitment at the highest possible level, to be sustained throughout the life of the mission.

6. Through a process of national dialogue, developing countries could identify a prioritized list of missions in the major domains of development, integrating science and technology with their development objectives and strategies. The missions would be used as principal instruments for specifying and coordinating domestic and external resources.

7. Countries interested in applying this approach could be aided by those that have already done so in identifying national problems amenable to the approach and in formulating and implementing technology missions. It is therefore proposed that

information on technology missions, as well as case-study experiences, be given widest dissemination.

A. Formulation

8. Governments, in collaboration with potential stakeholders, should review options for priority action and identify those areas in which technology missions would be the most appropriate means of providing the required action and inputs to ensure the speedy and successful resolution of the given problems.

9. During the phase of conceptualizing an appropriate technology mission, a broad outline of what has to be done, how it has to be done, and by whom it has to be done should be determined. The resulting decisions should be a portfolio of prioritized actions in the form of technology missions. This is necessary as a basis on which the pledging of support and the mobilization of resources can be undertaken.

10. A firm commitment should be obtained from each of the stakeholders to be directly involved in the implementation of the technology mission so that necessary administrative steps can be taken to launch that mission.

B. Definition of objectives

11. When it has been decided to embark upon a technology mission, the first priority is to translate the broad concept of what has to be done into a clearly defined objective, specifying both its qualitative and quantitative aspects. If sub-objectives are considered necessary, they should be unambiguously defined and accurately positioned in relation to the overall objective and to a detailed time-scale. Wherever feasible they should be formulated and arranged in such a way that the attainment of tangible, measurable goals can be readily recognized at specified evaluation points along the defined pathway to the completion of the mission.

C. Stakeholders

12. Stakeholders are individuals, groups of individuals, institutions or organizations that have some interest in the problem concerned or may be affected by it or could have a role to play in solving it. Stakeholders could thus include: (a) national and local authorities and agencies of Governments; (b) parastatal organizations and agencies; (c) individual scientists, engineers, technologists, etc.; (d) industry; (e) non-governmental organizations and private voluntary organizations; (f) general public and community leaders; (g) local associations; (h) external donor agencies, if necessary. Where appropriate, special consideration might have to be given to vulnerable segments of society, such as women, children and the handicapped.

13. The nature and degree of involvement of each stakeholder in a technology mission can only be defined within a specific context. However, in all cases, the emphasis should be on the building of a consensus opinion and on participatory decision-making at every possible stage in the creation and implementation of the mission.

D. Strategy and methodology considerations

14. The selection of a strategy or set of strategies that will most appropriately facilitate the attainment of the specified objectives is a critical decision which will have a profound influence on the outcome of a technology mission. The choice of strategy will usually be made early during the formulation phase of the mission.

15. Matching the selected strategy to specified objectives and schedule will lead to the formulation of an operational plan which may be subject to evaluation and eventually to revisions, as the mission proceeds.

16. An inspired leadership team open to innovative ideas will foster a judicious blending of traditional methodologies with newer technologies in such a way that the task to be undertaken will be fulfilled most efficiently and in an environmentally acceptable manner.

17. The successful use of techniques or technologies applied to technology missions will, in many cases, extend to other applications beyond the ones for which they were initially intended. Thus, the mission may generate import spin-offs and other benefits that can increase national capacity to tackle other developmental problems.

E. Organizational structure

18. A technology mission should have a separate, autonomous organizational structure to be responsible for the overall direction and management of the mission, including planning, programming, implementation and linkages. The established structure should be unconventional to the extent that it allows considerable managerial latitude and flexibility, thereby reducing the risks of bureaucratic bottlenecks that could otherwise impede the elements of urgency and expediency, which are considered essential ingredients of the mission.

19. Overall responsibility for purpose, scope and resources of a mission should be vested in a committee which includes representatives of the principal stakeholders. The committee would review mission execution and evaluate progress according to set objectives. It would also pay attention to interdepartmental linkages and coordination. Evaluation and audit exercises should be conducted in a manner to make the mission accountable and transparent.

F. Management

20. The less conventional structure of a technology mission requires that flexibility in the implementation phase is needed, inter alia, to accommodate unavoidable surprises and to swiftly introduce any required changes. Operational plans are important tools for coordinating a variety of different actions and events, based on decentralized decision-making processes. In addition, interactive management techniques and methods of communication serve both as means of securing cohesion and harmonization and as means to minimize risks and to optimize the tapping of existing local resources.

21. In order to ensure continued and increasing public support and governmental backing, the management should use the most effective communication systems available to publicize its activities and ensure maximum visibility.

G. Monitoring and evaluation

22. Monitoring of operations, other activities, and the procurement/utilization of resources should be a continuing process. Data collected by such monitoring should be accurate and concise, and should facilitate updating the analysis and documentation of results.

23. As predetermined steps in the implementation of the mission, the overall coordinative committee should conduct comprehensive technical and budgetary evaluations in relation to the plan of operations and the overall objective.

H. Linkages

24. Implementation of a technology mission will usually require the utilization of scientific and technological support services, access to technical expertise and the adaptation or development of suitable technologies. These requirements will demand the establishment of efficient linkages between the mission's management and technical units and local science and technology institutions, as well as with industrial and services enterprises involved in the mission. Other types of linkage will also be necessary to ensure the effective dissemination of the mission's results and achievements.

25. The fostering of linkages is one of the relevant external benefits to developing countries, many of which have difficulty in linking science and technology institutions with the productive sector. Thus, the establishment of technology mission-related linkages is another way in which those missions can contribute to endogenous capacity building.

I. Completion and follow-up

26. Once the planned objectives have been attained, the mission team is disbanded and any follow-up responsibilities have to be transferred to an appropriate and durable institutional entity. Likewise, the management of any residual/follow-up activities should be integrated into an existing developmental infrastructure and mechanism. The latter could be, for example, a department in a local government, an institution or a non-governmental organization, with the choice being governed by such criteria as technical and administrative competence, flexibility and proximity.

27. With regard to the funding of follow-up activities, it is highly desirable that this responsibility be assumed by an appropriate in-country entity. Should this create difficulties, it might be necessary to have the national funding effort complemented by external contributions - bilateral or multilateral, whichever is deemed most appropriate and feasible.

Annex IV

FINANCING SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

1. The request from the Intergovernmental Committee to include the financing of science and technology for development should be taken up in the context of the general issue of strengthening endogenous capacity building in developing countries. It is necessary to stress the importance of countries investing in the long-term task of building endogenous scientific and technological capabilities for management of technological change, in spite of the severe resource constraints faced by many developing countries.

2. So far the Advisory Committee's work has concentrated on financial resources for endogenous capacity development in key areas related, for example, to human resource development, promotion of linkages, technological innovation and various technology services. Further focus was also given to the following three aspects:

(a) Assessment of the financial requirements for endogenous science and technology development;

(b) National sources of funds;

(c) External sources of funds.

A. Mobilizing private and public sectors at the national level

3. Although many developing countries have taken steps in recent years to increase the participation of non-governmental sectors, the share of the State still predominates by far. Most scientific and technological activities in developing countries are undertaken by institutions belonging to the State sector, which is financed in the main by the national budget.

4. It is felt that the time has come to consider establishment of a consolidated budget providing for endogenous scientific and technological capacity-building activities, which should embrace both the private and public sectors, as well as different sectoral ministries and agencies.

5. Funding at the national level remains essential. Mechanisms should evolve so that an increasing part of the contribution can be drawn from the private sector as the latter's capabilities as user of technology grow. Faced with an increasingly globalized international market, the pressure to enhance competitiveness in both cost and quality, and the need for a resilient capacity to tackle technological change, the requirement for endogenous capacity building becomes ever deeper and broader. Productive enterprises, individually or collectively, must be guided to build up their own capabilities for information search, specialized training and adaptive re-engineering of processes and product modification to increase their resilience to recurrent external shocks and unexpected changes in their constraints and potentialities. Stimulation of private firms to organize and run in-house

technical activities requires flexible, but well disciplined governmental support policies. Familiar instruments include:

(a) Grants to train personnel for specific skills and to train such trainers. Training may take place either within the country or abroad; either all or part of costs may be covered by the government grant depending on the extent to which the acquired skills are generic in nature, and thus can be regarded as a "public good", or on whether they are firm-specific, i.e. an asset, to be internalized within the recipient firms;

(b) Grants to universities and local technology institutes on the basis of joint R&D activities involving local companies' R&D units. If research and development are pre-commercial in nature, these grants may not be tied to return payment, but grant-like loans in a "revolving-fund" type of framework may become justifiable so that royalties, in case of final commercial success, can be collected to replenish the original funds;

(c) Risk-financing of loans to innovations at close to commercial level, with subsidization to the extent that the risks envisaged are beyond what private entrepreneurs could absorb by themselves.

B. Mechanisms for financing science and technology from external sources

1. Bilateral aid

6. It would be advisable for donors to pay much more serious attention to the endogenous capacity-building facet of their aid project, so that a due percentage of their project budget will be earmarked to finance extra training, R&D, and technological diffusion activities in recipient countries. In the case of a large-scale project of relatively long duration, especially, this percentage can be of a substantial order, in order to ensure that the project will have a lasting impact on the recipient country's process of endogenous capacity building.

7. Fuller cooperation of the bilateral donors is solicited with the aim of satisfying the critical mass of science and technology capabilities associated with other investments in development.

2. Multilateral resources

8. Multilateral resources are generally acknowledged to be more catalytic, strategic, non-conditional and more responsive to national priorities. But there has been a tendency for development financing institutions to be less responsive to post-project, maintenance requirements of the original investments, which more often than not reveal the inadequacy of the endogenous capacity-building ingredients of those investments. Furthermore, these development institutions did for some time play down the linkage between development infrastructural investment and investment in science and technology-related institutions. Their attention to

the problem of endogenous capacity building seems to be increasing only today, as witnessed in the provisions for large-scale scholarship programmes associated within or parallel to their investment-loan programmes.

9. In spite of the multitude of United Nations activities in the field of development cooperation, there has been a growing recognition of the need to introduce a clearer frame of reference centring on the concept of endogenous capacity building. Consideration by the United Nations Development Programme (UNDP) of the impact of technology on development in their nation-to-nation programme supervision could go a long way towards integrating scientific and technological variables into both overall and sectoral development. The extrabudgetary resources that countries contribute to UNDP, as a central funding mechanism, can contribute, if properly targeted, to technological development.

10. The recent UNDP decision towards national execution implies an enhanced future role of UNDP in the coalition of resources (as among national, bilateral and various NGO-funded sources) to promote concerted efforts at generating and building up mechanisms for cooperation towards sustainable development.

11. A recent policy shift of UNDP also favours a "programme approach" in place of the traditional "project approach". While the "programme approach" in the UNDP context seems yet undefined, the Advisory Committee hopes that the theme of coalition of resources towards endogenous capacity building will receive active attention on the part of both national Governments and UNDP.

3. Proposed coalition of resources

12. The Advisory Committee noted that the efforts within the United Nations to establish a long-term financing system for science and technology for development has largely failed.

13. Given this failure, the Committee has recommended a new approach for funding endogenous capacity building based on a coalition of internal and external resources.

14. Such a coalition would imply matching alternative sources of funds, both domestic and international, with the financial requirements of prioritized projects as defined by a national science and technology strategy. In the formulation of such a strategy, the Committee has recognized the importance of incorporating the views of the main stakeholders in the development process. This approach would be consistent with that recommended in a recent report of the Development Assistance Committee of the Organisation for Economic Co-operation and Development which concluded that "the full integration of science and technology into the development process through the building of national capacities and coordinating domestic and international efforts through a set of key development missions is a major exciting task for the 1990s".